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Dias da Silva, Antonio; Klaauw, Bas van der

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Antonio dias da Silva
Bas van der Klaauw

Vrije Universiteit Amsterdam, and Tinbergen Institute.

Tinbergen Institute
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Tinbergen Institute Amsterdam
Roetersstraat 31
1018 WB Amsterdam
The Netherlands
Tel.: +31(0)20 551 3500
Fax: +31(0)20 551 3555

Tinbergen Institute Rotterdam
Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31(0)10 408 8900
Fax: +31(0)10 408 9031

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Wage dynamics and promotions inside and between firms

António Dias da Silva* **Bas van der Klaauw†**

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Abstract

We focus on the dynamic relation between wage increases, promotions and job changes. We relate our empirical analyses to the theoretical model of Gibbons and Waldman (1999). In the empirical analyses we use the Portuguese matched employer-employee data Quadros de Pessoal. We conclude from finding significant serial correlation in wage increases and promotion rates that employer learning about the worker's ability might be important. Furthermore, we find that the Portuguese labor market is not competitive. Finally, we argue that employer-reported promotion relate to a large extent to wage increases rather than changes in job tasks and complexity.

*Free University Amsterdam and Tinbergen Institute. E-mail: silva@tinbergen.nl

†Free University Amsterdam, Tinbergen Institute, Scholar, IFAU, IZA and CEPR. E-mail: bklaauw@feweb.vu.nl

Address: Department of Economics, Free University Amsterdam, De Boelelaan 1105, NL–1081 HV Amsterdam, The Netherlands.

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1 Introduction

Career development inside the firm is an important source of wage increases. Topel and Ward (1992), for example, show that for young workers only about one third of the wage increases can be attributed to job changes. This implies that the most substantial part of the wage increases occurs inside the firm. Wages can increase for many reasons while working in the same firm, workers develop (firm's specific) human capital, firms learn about workers' productivity, etc. The internal labor market is characterized by a relatively well defined hierarchy, which workers can climb. Promotions to higher hierarchical levels are often associated with wage increases. In the internal labor market other worker factors can be important than those that determine the initial match between the worker and firm.

In this paper, we focus on the relation between wage increases, promotions and job changes. In a dynamic framework, we investigate to what extent promotions and job changes can be predicted by the past career path and how promotions and job changes affect wage increases. We relate our empirical results to the theoretical model of Gibbons and Waldman (1999). This model explicitly deals with learning of the firm about the worker's ability as explanation for promotions and wage increases. Our empirical results, therefore, provide insight in the importance of learning for worker's careers.

The model of Gibbons and Waldman (1999) has more often been used in empirical analyses of career mobility. Lluis (2005) estimates the model to study career mobility in Germany. Her focus is on the underlying assumptions of the model and the role of comparative advantages. Lluis (2005) considers four hierarchical levels and concludes in favor of job assignment but does not find evidence that learning plays a role explaining the dynamics of wages. Gibbons, Katz, Lemieux and Parent (2005) apply the model to sector wage determination. Our approach differs from these papers in the fact that both papers focus mainly on the underlying assumptions of the model rather than investigating the model predictions.

In the empirical analyses we use the Portuguese matched employer-employee data Quadros de Pessoal, which is based on an annual enquiry of all firms with wage earners in the private sector. The data set contains detailed information

on both firms and workers. The data contain the worker's hierarchical level, which is ranked by a well-defined hierarchy. Changes in the hierarchical level are a measure for promotions. Additionally, the firm reports if the worker has been promoted in the past year. In the empirical analyses we use both measures for promotions to investigate the extent to which the definition of promotions is important.

In the theoretical literature a promotion is considered to be a change in hierarchical level accompanied by a change in the worker's production technology (e.g. Bernhardt, 1995; Gibbons and Waldman, 1999). Prendergast (1993) defines hierarchical levels in terms of how demanding they are for human capital, while Manove (1997) defines hierarchical levels by the degree of worker's responsibility. In the empirical literature not much attention has been devoted to the definition of promotions. A substantial share of the empirical work considers only one single firm, which has the advantage of having a clear hierarchy in jobs. Still even within a single firm the hierarchy in jobs is not always obvious. Lazear (1992) defines promotions as movements from a job title with a lower average pay to a job title with a higher average pay, while Baker, Gibbs and Holmstrom (1994a) use yearly patterns of job transitions to infer promotions. More recently Treble, Van Gameren, Bridges and Barmby (2001) use the hierarchy defined by the firm with 14 levels and Gibbs and Hendricks (2004) use records of one firm which include information on every job change for every employee, including promotions categorized by the personnel department. Individual-based data face the problem of having to rely on subjective promotion concepts, e.g. workers might associate promotions to wage increases rather than to changes in the hierarchy. McCue (1996) uses the Panel Study of Income Dynamics, where the definition of promotions is based on position changes reported by respondents. Booth, Francesconi and Frank (2003) use the British Household Panel Survey, where also the timing of promotions and type of job change is reported by the workers. Pergamit and Veum (1999) show the sensitivity of empirical results on job assignments and wage increases to different promotion definitions. Using the National Longitudinal Survey of Youth they conclude that for a substantial fraction of the individuals a promotion does not mean a change of position. Overall, after a self-reported promotion about

30% of the workers remains to perform the same tasks as before.

This paper is organized as follows. In Section 2 we discuss some theory concerning promotions and wage increases, and we provide our empirical specifications. From the theoretical literature, we take some predictions that we test in our empirical analyses. Section 3 provides a detailed description of the data. In Section 4 we present our empirical results. Section 5 provides sensitivity analysis of our results. Section 6 concludes.

2 Theoretical background

The economic literature on promotions is driven by a number of stylized facts (e.g. Baker, Gibbs and Holmstrom, 1994a, b). Promotions are often associated with large wage increases. Promotions are, therefore, not only used to assign workers to jobs, but can also act as incentives structures to workers. However, wage increases at promotions are small relative to differences between averages wages across hierarchical levels. Both wage increases and promotions are often found to be serially correlated. Large wage increases during a stay at one hierarchical level often predict promotions to the next hierarchical level. The final stylized fact is that real wage decreases are not rare, but demotions are.

Most of the recent theoretical frameworks take these stylized facts as point of departure for modeling the role of promotions inside firms. For example, Owan (2004) and Costrell and Loury (2004), who focus more on the importance of promotions in assigning workers, and Kwon (2006), who considers promotions in the contexts of optimal contracts and incentives for human capital accumulation. Bernhardt (1995) developed a model that includes human capital accumulation, job assignment and asymmetric learning. In this framework workers develop general and firm specific skills and the ability of these workers is only observed by the current employer. Firms have two hierarchical levels called labor and management, and more able workers have a comparative advantage in management. The model of Bernhardt (1995) predicts that wage increases at promotions are large and these wage increase may be small relative to the difference in average wages between hierarchical levels. However, this model fails to explain that wage increases predict pro-

motions and the serial correlation in promotion rates and wage increases is not addressed. The model of Gibbons and Waldman (1999) performs better in explaining the stylized facts. Their model considers symmetric learning by workers and firms, which we use as starting point for our empirical analyses.[1]

Gibbons and Waldman (1999) consider two types of workers with (unobserved) innate ability θ. Firms do not know in advance if a worker is of high or low ability, but while working both the worker and firm learn about the worker's innate ability. The worker's effective ability η_t at time t depends on the innate ability θ and the current level of the worker's labor market experience x_t. In particular, $\eta_t = \theta f(x_t)$, where $f(\cdot)$ is a concave function. A worker, who is assigned to hierarchical level j, produces according to the technology $y_{jt} = d_j + c_j(\eta_t + \varepsilon_t)$, where c_j and d_j are known constants and ε_t are idiosyncratic shocks, which may be aggregate or person-specific productivity variations.

The existence of the productivity shocks introduce noise in the output produced. The worker's output in each period provides a signal $z_t = (y_{jt} - d_j)/c_j = \eta_t + \varepsilon_{jt}$. The model specification causes that both the worker and the firm only learn gradually about the worker's innate ability and that learning is independent of the job assignment, $\theta_t^e = \mathrm{E}[\theta | z_{t-x}, ..., z_{t-1}]$. Gibbons and Waldman (1999) impose some regularity conditions on c_j and d_j and show that a worker is promoted to the next hierarchical model if the expected effective ability $\eta_t^e = \theta_t^e f(x_t)$ increases some threshold η^j. Gibbons and Waldman (1999) assume that learning about the worker's ability is not exclusive to the current employer, but all labor market participants have access to the same information. Wages are determined on a competitive market and equal expected output $w_{jt} = \mathrm{E}[y_{jt}] = d_j + c_j \theta_t^e f(x_t)$.

Gibbons and Waldman (1999) distinguish two cases; *symmetric learning* where both the worker and firm learn about the worker's innate ability, and *full information* where the innate ability is always known to both the worker and firm. Under full information past realizations of the worker's productivity are not informative on the worker's innate ability. Wage increases are therefore only the consequence of increased work experience and promotions. High ability workers accumulate effective ability at a higher rate,

[1] See Gibbons and Waldman (2006) for an extension of their earlier model.

which causes serial correlations in wage increases. However, conditional on the worker's innate ability serial correlation in wage increases is absent. Under symmetric learning even after conditioning on the worker's innate ability, past realizations of the worker's productivity remain important. Conditioning on the true worker's innate ability is, therefore, not sufficient to remove the serial correlation in wage increases. Workers who experience large wage increases are also more likely to be promoted as firms believe these are high innate ability workers. These workers also spend less time in a hierarchical level before being promoted to the next level. This causes that wage increases predict promotions and that promotions are serially correlated. Testing for symmetric learning thus implies distinguishing between heterogeneity among workers and true state dependence in promotions and in wage increases. Gibbons and Waldman (1999) assume a competitive labor market, where all firms learn at the same rate. This implies that both in case of full information and symmetric learning, there is no wage premium of changing employers.

We test these predictions using reduced-form model specifications. Since the model predictions are informative on wage increases, we specify our empirical wage equation in increases in levels. Under the null hypothesis of full information in a competitive market, wage increases only depend on the worker's innate ability θ_i, the level of labor market experience x_{it}, whether or not a promotion occurred p_{it} and the worker hierarchical level h_{it}. If there is symmetric learning, there is serial correlation in wage increases, implying that after controlling for the factors mentioned above and the wage level w_{it-2}, the wage increases $w_{it} - w_{it-1}$ and $w_{it-1} - w_{it-2}$ are correlated. The reason for conditioning on the wage level w_{it-2} is to control for all information already revealed to the market about the worker's innate ability. If learning is not symmetric or the market is not competitive, there might be a premium to switching employers even if the worker stays within the same hierarchical level. We denote a separation from the current employer by s_{it}. Our empirical wage equation therefore follows

$$w_{it}-w_{it-1} = \beta_1(w_{it-1}-w_{it-2})+\beta_2 w_{it-2}+\beta_3 p_{it}+\beta_4 s_{it}+\beta_5 x_{it}+g_1(h_{it})+\theta_i+\varepsilon_{it}.$$

where the function $g_1(h_{it})$ is a linear function including dummy variables

for the hierarchical levels. If in a competitive labor market there is full information, then $\beta_1 = 0$, $\beta_2 = 0$ and $\beta_4 = 0$. Symmetric learning in a competitive labor market implies $\beta_1 \neq 0$ and $\beta_4 = 0$. And if learning is either not symmetric or the labor market is not competitive, then $\beta_4 \neq 0$.

Under full information promotions depend only on the worker's innate ability, the level of labor market experience and the current hierarchical level. If there is symmetric learning, there remains serial correlation in promotions and promotions can be predicted by wage increases. In a competitive market both under full information and under symmetric learning, the rate at which promotions occur should not depend whether the worker recently changed employer. Therefore, we specify for promotions the empirical model

$$p_{it} = \alpha_1(w_{it-1} - w_{it-2}) + \alpha_2 w_{it-2} + \alpha_3 p_{it-1} + \alpha_4 s_{it-1} + \alpha_5 x_{it} + g_2(h_{it}) + \varphi_i + \epsilon_{i,t}$$

In this model specification, full information implies $\alpha_1 = 0$, $\alpha_2 = 0$, $\alpha_3 = 0$ and $\alpha_4 = 0$. If in a competitive market there is symmetric learning, then $\alpha_1 \neq 0$, $\alpha_3 \neq 0$ and $\alpha_4 = 0$. And finally, if either the market is not competitive or learning is not symmetric, then $\alpha_4 \neq 0$.

Finally, in a competitive labor market with either full information or symmetric learning job separations should be unrelated to past wage increases and whether or not recently the worker experienced a promotion. To model job separations we use the specification

$$s_{it} = \gamma_1(w_{it-1} - w_{it-2}) + \gamma_2 w_{it-2} + \gamma_3 p_{it-1} + \gamma_4 s_{it-1} + \gamma_5 x_{it} + g_3(h_{it}) + \varsigma_i + \zeta_{it}$$

In case other firms have the same information about the worker as the current employer (full information or symmetric learning) and the labor market is competitive, then the prediction is that $\gamma_1 = 0$, $\gamma_2 = 0$ and $\gamma_3 = 0$. If any of these variables is non-zero, the labor marker is not competitive or learning is asymmetric.

In our empirical analyses, we will also try to include additional control variables besides the variables already mentioned above. In particular, we include the firm's size (measured by the number of workers), year dummies and sector indicators. These variables should control for the firm's technological function. In Section 4 we discuss the details of our estimation procedure

and the empirical results.

3 Data

In the empirical analyses we use the Portuguese matched employer-employee data set Quadros de Pessoal. These data are annually collected by the Ministry of Employment, based on a survey that every firm with wage earners has to fill in. The data do not cover public administration, domestic service and self-employed workers. The compulsory nature of the survey guarantees that each year information for more than 2 millions workers is recorded. Quadros de Pessoal provides information on individual characteristics such as gender, age, schooling, occupation, tenure, earnings, and hours of work. Firm characteristics include location, employment, sales, ownership, and legal setting. Both firms and workers have identification codes that permit to track them over time. For employers it is mandatory to post the firm's response to the survey questions concerning the information on employees in a public place inside the firm. This should reduce measurement errors in the data.

In our empirical analyses we use data from 1991 to 2000. The data are collected once per year. Until 1993 the data were collected in March. After 1993 the data are collected in October. In the empirical analyses we deal with this discrepancy by including year dummy's. Furthermore, we perform sensitivity analyses where we only consider the period after 1993. We restrict the sample to full-time workers who were between 16 and 65 years old. In total the data contain 4,202,736 workers, who are observed in 16,245,140 years, from which we use a 10% random sample. We have done some consistency checks on the data. If we found an inconsistency in the variables gender, birth date, tenure in the firm or school level, this was repaired if possible or otherwise the worker was dropped from the data. In total we excluded 183,932 observations for which we did not manage to recover the correct values of the variables.

The data contain five components of monthly earnings, a base-wage, tenure-indexed components, other regularly paid components, non-systematic payments and extra-time work payments. As the relevant wages we take the sum of the base-wage, the tenure-indexed components and the other regularly

paid components. We do not take the other two components into account as these are specific to the month in which the data were collected. The amounts presented are before taxes and social security contributions and refer to October of each year (or March for the period 1991-1993). We have deflated the wages using Consumer Price Index to constant (2000) PTE. To reduce measurement errors in the wages we have excluded workers who experienced a wage increase in top 10 percentile in one year and in the lower 10 percentile in the next year (or vice versa). This implies a loss of 119,185 observations. The remaining data set contains 363,383 individuals and 1,323,298 observations.

The Quadros de Pessoal contains three types of variables that reveal information about workers' mobility inside firm. Most detailed is the professional category, which contains over 60,000 possible job descriptions. Since there is no natural ranking in these job descriptions, using changes in professional category as measure for promotions is not attractive. The second source of information about workers' mobility is the hierarchical level, which is based on skills and tasks. The data distinguish eight hierarchical levels (full description in the Appendix) defined by law (Decreto-Lei n.^{o} 121/78, 2 June):

(Level 1) apprentices, interns, trainees;

(Level 2) non-skilled professionals;

(Level 3) semi-skilled professionals;

(Level 4) skilled professionals;

(Level 5) higher-skilled professionals knowledge;

(Level 6) supervisors, team leaders, foremen;

(Level 7) intermediary executives;

(Level 8) top executives.

A promotion is defined as a movement from a lower to a higher hierarchical level. To reduce misclassification in hierarchical levels, we have used the information on the professional categories. Since the professional category is much more detailed than the hierarchical level, we consider changes in the hierarchical level that did not imply a change in professional category as misclassifications. The final measure for worker's mobility is the reported date of most recent promotion. If the date of last promotion is posterior to October of last year (or March for the period 1991-1993), we consider that the worker was promoted. It should be stressed that it is the firm who reports

this promotion date, which most likely reduces the level of subjectiveness in what is considered to be a promotion.

Since we can track firms and workers over the years we are able to identify workers movements between firms. We define a separation as a worker movement from one firm to another in two subsequent years. We use data on tenure to control for misclassifications in separations.

In Table 1 we present some descriptive statistics of the data. The mean monthly wage is 125,762 PTE, which is about 627 euro. Workers experience on average an annual wage increase of 5329 PTE, which is 3.8% of the mean wage. Approximately 7% of the workers change hierarchical level in two subsequent years. However, the firms indicate that 11.2% of the workers got promoted. The majority of the workers that got promoted, according to the firm, do not change hierarchical level. Only 2% of all workers are promoted according to the firm and change hierarchical level in the same year. This suggests that both promotion concepts measure different movements within the firm. Furthermore, about 4.4% of the individuals switch firms and 1.1% of all workers move to a higher hierarchical level at the same time they switch firms.

About 41% of the workers in our sample are female and they are on average 36 years old. On average a worker has 8 years of tenure within the current firm. The mean firm size is 30 workers. Almost half of the workers are qualified professionals, which is the fourth hierarchical level out of eight possible levels. Only about 3 percent of the workers are top executives, which in the highest hierarchical level. Compared to other European countries, the level of education in Portugal is low. About 42% of the workers only completed four years of primary education, while only about 18% of the workers finishes High school. Finally, we distinguish 18 sectors of economic activity. The two biggest sectors are trade, and textile, clothing and leather employing 18% and 17% of the workers, respectively.

Table 2 presents job mobility by gender and age group. We have categorized the transitions into five different possibilities: no change; separation to the same hierarchical level in another firm; separation to a higher hierarchical level in another firm; promotion inside the firm to a higher hierarchical level; and promotion inside the firm in the same hierarchical level. The latter type

of promotions are based on the most recent promotion date reported by the firm. The general picture does not differ much between men and women. About 80% of the both men and women do not make a change. Men are slightly more likely to switch employers, while women more often make a transition inside the firm to a higher hierarchical level. Mobility declines as workers get older. For the oldest age group most mobility comes from promotions inside the same hierarchical level. A natural explanation that older workers are less often promoted to higher hierarchical levels is that these workers are already in the higher hierarchical levels and there are thus fewer possibilities for increases.

McCue (1996) and Lluis (2005) have documented similar statistics for workers' mobility for respectively the US and Germany. Portugal has lower separation rates than the US and Germany, which is particularly the case for the younger inexperienced workers. Internal job mobility rates are much higher in Portugal. However, this might also be caused by differences in the definition of promotions. Both McCue (1996) and Lluis (2005) use data from questionnaires to individuals and thus rely on self-reported position changes by the workers. Furthermore, Lluis (2005) only distinguishes four hierarchical levels, which naturally reduces mobility compared to our eight hierarchical levels. McCue (1996) considers each self-reported position change by the worker as a promotion, but there might still be some discrepancy between worker and firm reported position changes.

Table 3 presents for each hierarchical level the average wage and some measures for mobility. Except for level 6 (supervisors, team leaders and foremen), the average wage is higher for workers in higher hierarchical levels. Workers in level 5 (higher-qualified professionals) are on average better educated than the workers in level 6, which might explain their higher average wage. Workers in level 8 (top executives) earn on average more than 5 time as much as the apprentices and trainees in level 1. Average wages particularly start to increase beyond level 4 (qualified professionals). Recall from Table 1 that less than 16% of the workers are ranked in hierarchical level 5 or higher.

As could be expected apprentices and trainees are most mobile. They are most likely to be promoted to higher hierarchical levels, within the level

or to switch employers. The likelihood of moving to a higher hierarchical level decreases quickly until reaching level 4 and remains roughly the same for higher hierarchical levels. Except for workers in the first level, all workers have similar probabilities of being promoted within the hierarchical level and to separate from the job.

Table 4 shows how workers move through hierarchical levels and the associated wage increases. Average wage increases associated to changes in hierarchical level are always higher than average wage increases of the workers who stay in the same level. In general average wage increases increase in the number of hierarchical levels a worker is promoted. However, workers are not very likely to skip hierarchical levels beyond the level of qualified professionals (level 4).

4 Results

In this section we discuss the estimation results of the empirical models introduced in Section 2. The empirical models follow the specification of a dynamic panel data model and therefore we follow the approach of Arellano and Bond (1991). After taking first-differences to eliminate the worker specific fixed effects, the specifications include the endogenous regressors $(w_{it-1} - w_{it-2}) - (w_{it-2} - w_{it-3})$, $p_{it} - p_{it-1}$ and $s_{it} - s_{it-1}$. As instruments for these endogenous regressors we use w_{it-3}, p_{it-1} and s_{it-1}. The remaining variables are treated as exogenous. We thus have as many instrumental variables as we have endogenous regressors, implying that our models are just identified. The estimation method requires that we observe a worker's wage in four consecutive years $(w_{it}, \ldots, w_{it-3})$. This implies that the empirical analyses are done on a sample of 106,305 workers who are in total observed in 659,497 years.

The theoretical model of Gibbons and Waldman (1999) has labor market experience as an important individual characteristic. However, the data do not contain information on work experience. Therefore, we use the worker's age as proxy variable for work experience, we include both age and age squared. Furthermore, we also include the worker's tenure (and tenure squared) as control variables in all model specifications. Finally, for each

model specification we estimate the model both without and with firm size, sector dummies and dummies for the different years of observation.

Table 5 presents the estimation results for the model of wage increases. The first two columns use job transitions to a higher hierarchical level as promotions, the last two columns use promotion dates reported by the employer as measure for promotions. From comparing the estimation results in columns (1) and (2) with those in columns (3) and (4), we see that the returns to a promotion reported by the employer are almost 30% higher than the returns to a job transition to a higher hierarchical level. This raises the suspicion that employers report wage increases as promotions rather than changes in job tasks or responsibilities. A job transition to a higher hierarchical level raises the wage with on average about 6500 PTE, which is around 5% of the average wage in our data. Our estimate is in line with earlier empirical work. McCue (1996) concludes that promotions account approximately 9% - 18% of within-firm wage growth over the life cycle. Booth, Francesconi and Frank (2003) find a wage prize for promotion of around 5%. And Lima and Pereira (2003) find, using the same data we use, for firms with more than 500 workers that a wage increase of 1.9% for a promotion inside the same level, 4.9% for a job transition to a higher hierarchical level and 8.3% for a job transition to a higher hierarchical level that coincides with an employer-reported promotion.

We do find evidence for serial correlation in wage increases. Serial correlation in wage increases (after controlling for individual heterogeneity) is an indication for symmetric learning. The size of the serial correlation is quite robust against the different measures for promotions and including additional regressors. On average, a wage increase causes that in the next year the worker gets an additional wage increase of about 10% of the previous wage increase. The serial correlation in wage increases is one of the stylized facts summarized by Baker, Gibbs and Holmstrom (1994b) but has mixed evidence in the empirical literature. Lluis (2005) did not find evidence of serial correlation in wages while Gibbs and Hendriks (2004) and Dohmen (2004) found some evidence of serial correlation in wages. Lluis (2005) uses survey data with self-reported wages, measurement errors in wages may cause a downward bias in the serial correlation in wage increases. Gibbs and Hen-

driks (2004) and Dohmen (2004) do not suffer from this problem as both use personnel records from a single firm.

The estimation results show that there are returns to switching employers. In all specifications there is a substantial wage premium associated to a job separation. This wage premium is higher in specifications (3) and (4) than in specifications (1) and (2). The main reason for this, is that if the worker moves to a higher hierarchical level while switching employers, then in specifications (1) and (2) it is recorded as both a promotion and a job separation while in specification (3) and (4) it is only recorded as a job transition. However, in all specification the wage premium associated to a job transition to another employer is about 70% of the wage increase associated to a promotion. The wage increases following a job separation remains unaffected after correcting for the number of workers in a firm and sector dummies. Raw statistics show that larger firms pay on average higher wages. Firm size and the sector dummies can be interpreted as indicators for the firm's production technology. Indeed, as is shown in specifications (2) and (4) wage increases are significantly larger in firms with more workers. This implies that the wage increase after a job separation cannot be explained only from workers moving to firms with better production technologies.

In Section 2 we discussed that in a competitive labor market, either with full information or symmetric learning, there would not be any wage premium associated to switching employers. The significant and substantial wage increase associated to a job separation thus indicates that the Portuguese labor market is not competitive. Obviously, employers have some bargaining power when determining wages, this might for example be due to job search frictions.

The estimation results for the linear probability model that workers get promoted are presented in Table 6. Wage increases do not forecast job transitions to a higher hierarchical level, i.e. in specifications (1) and (2) both the most recent wage increase and the lagged wage level do not have a significant impact on the probability to get promoted. In specifications (3) and (4) these wage variables do have a positive effect on the probability that the employer reports a promotion and in specification (3) both estimated covariate effects are even significant. This provides again evidence that em-

ployers report as promotions wage increases rather than changes in job tasks or responsibilities. Ariga, Ohkusa and Brunello (1999), who using data from one Japanese firm, analyze promotions inside horizontal ranks, which do not imply a change in job complexity or responsibilities. They find that wage increases forecast promotions. Dohmen (2004) focusses on changes in hierarchical levels and concludes that the effect of wage increases on the promotion probability disappears after include the controls for tenure, age, education and performance evaluation. These finding coincide with our interpretation that employer-reported promotions describe substantial wage increases rather than changes in job tasks or responsibility.

In all specifications there is positive serial correlation in promotions, although the coefficient of serial correlation is much larger in case promotions are measures as job transitions to a higher hierarchical level. Workers who switched employers have significantly lower probabilities to get promoted in the next year. The impact of a job separation on the promotion probability is more than twice as large in specification (3) and (4) as in specifications (1) and (2). Recall from Section 3 that annually about 7% of the workers move to a higher hierarchical level, while firms indicate that slightly over 11% of the workers get promoted. So not only the absolute impact of a job separation of promotions is larger in specification (3) and (4), but also the impact relative to the average annual promotion probability. Serial correlation in promotion rates is one of the main findings in the empirical literature (e.g. Seltzer and Merrett, 2000; and Treble, Van Gameren, Bridges and Barmby, 2001).

Both age and tenure have significant impacts on promotion probabilities. Promotion rates in terms of job changes to higher hierarchical levels are highest around age 52 and after 20 years of tenure. Promotion reported by the employer are decreasing in age (during working life) and are lowest after 17 years of tenure. Firm size has an opposite impact on the two concepts for promotions. In larger firms workers are significantly more likely to make a job transition to a higher hierarchical level, while it is significantly less likely that the employer reports a promotion.

Our third model describes job separations. The estimation results for this linear probability model are given in Table 7. In all four specifications

it holds that both wage increases and promotions forecast job separations. This finding contradicts Sicherman and Galor (1990), who argue that worker may separate from their job if their career path does not fulfill the worker's expected career path. Also Lazear (1999) predicts a negative correlation between job separations and both promotions and wage increases. A possible explanation for the positive correlation we find, is that in a market with asymmetric information, both promotions and substantial wage increases can be signals about the worker's (unobserved) productivity. Other employers may therefore make higher wage offers to these workers.

We find serial correlation in job separations, implying that workers who recently moved employer are more likely to move again. Also age and tenure have significant impacts on job separation rates. Young workers are most mobile and the likelihood of switching employers decreases during working life. Job separation rates are increasing in tenure until about 22 years of tenure. Finally, in firms with more workers job separation rates are significantly higher than in firms with less workers.

The main conclusions we can draw from these estimation results is that most likely the Portuguese labor market is not competitive. There are substantial and significant impacts from job separations on both the probability of getting promoted and on wage increases. The serial correlation in wages and promotions indicates that learning is important. One might question whether learning is symmetric as promotions and wage increases also forecast job separations. Finally, it seems that promotions reported by employers measure to a large extent wage increases rather than changes in job tasks and responsibilities. The returns to these self-reported promotions are much larger than the returns to job transitions to a higher hierarchical level.

5 Sensitivity analysis.

In this section we perform some additional analyses to investigate the robustness of our empirical results. In the tables we only report the estimation results of the most extensive models, i.e. those including the number of workers, sector and year dummies as covariates.

Recall that until 1993 the data were collected in March, while from 1994

onwards the data were collected in October. It might be that between the 1993-wave and the 1994-wave more promotions and wage increases occurred due to the extended time period. This might bias our parameter estimates. Therefore, as a first sensitivity check we have estimated our models only using the data collected after 1993. In the model for wage increases the relevant coefficients increase slightly (see Table 8). The serial correlation in wage increases becomes larger as are the returns to promotions and job separations. In particular, the wage premium from a job separation increases with about 35% compared to the earlier estimates. Finally, the covariate effect of the number of workers almost doubles. The estimation results for the promotion probability and the job separation rate do not change much (see Tables 9 and 10). We only find that the effect of the number of workers changes somewhat. The main conclusions from the previous section remain valid. The Portuguese labor market is not competitive, there is some evidence for learning and both promotion concepts differ substantially in what they measure.

Next we perform separate analyses for men and women. The idea is the men and women might sort into different types of occupations or jobs and that therefore their promotion opportunities differ. The estimated coefficients in the model for wage increases differ substantially between men and women (see Table 11). State dependence in wage increases is only present for men. Furthermore, the returns to both a promotion or a job separation are much larger for men than for women. The results for the promotion rates do not differ much between men and women. If we focus on changes in hierarchical levels only the negative effect of a job separation on promotion rates is larger for women. For both men and women the serial correlation in promotion rates is similar and we do not find that wage increases forecast promotions. If we consider employer-reported promotions, there is a negative serial correlation in promotions for men, while only for women wage increases predict promotions. For both men and women the results change if we change the promotion concept. As one can see from Table 13 there are no substantial differences between men and women in the estimated coefficients for the job separation rate. The results for the wage increases seem to indicate that men select themselves more into job types where the re-

turns to promotions are higher and where learning is more important. This might imply that men work in occupations where unobserved ability is more important in explaining the worker's production function.

The final sensitivity analysis relates to the worker's education. Education is often considered as a signal about a worker's ability. Furthermore, workers with different levels of education sort themselves into different types of jobs. We distinguish three types of workers, workers with only completed primary education (low education), workers who completed the second or third ciclo (medium education), and workers who completed high school or more (high education).

The estimation results on the wage increases show that serial correlation in wage increases is highest for the workers with low and high education (see Table 14). For workers with medium education the serial correlation in wage increases is small and insignificant. The wage increase upon promotion is significant for all groups, but much higher for the workers with high education than for both other groups. The workers with high education benefit most from switching employers. The premium associated to an employer change is twice the wage increase of a promotion. For both other groups the wage increase upon switching employers is relatively small. These results imply that the market for low educated workers is rather competitive, but that learning is relatively important for these workers. An alternative explanation is that wage for low educated workers are largely arranged by collective bargaining agreements and that therefore switching employer does not yield large wage increases. For the higher educated workers the market is less competitive and learning is less important. This might be explained from the fact that education levels are relatively low in Portugal. Since many people (45%) do not have any education higher than primary school, the schooling level of these individuals might not be a very good signal about their ability. Those individuals who have higher levels of schooling distinguish themselves from the majority of the population and therefore for them their educational attainment corresponds relatively good to their ability.

For all educational levels we find serial correlation in promotion rates (see Table 15). Also workers who switched employers are less likely to get promoted in the following year. For the lowest educated workers, there is

a significant negative relation between wage increases in promotion rates. This contradicts the learning model of Gibbons and Waldman (1999). For the workers with medium and higher education wage increases do not have a significant effect on promotion rates. Finally, for all groups we find significant serial correlation in job separation rates (see Table 16). Promotions and wage increases significantly increase the probability of switching employers, although these effects become smaller (and insignificant) as the level of education increases.

6 Conclusion

In this paper we analyzed the dynamic relations between wage increases, promotions and job changes. We have used the theoretical framework of Gibbons and Waldman (1999) to construct empirical models for wage increases, promotions and job changes. The model of Gibbons and Waldman (1999) provides some testable implications on the importance of learning by the employer about the worker's ability. In the empirical analyses, using the Portuguese matched employer-employee data Quadros de Pessoal, we mainly focus on these testable implications.

In the empirical analyses we have used two definitions of promotions, which are also often used in the literature. First, promotions defined as changes in hierarchical levels, which is in line with the idea of a promotion in the theoretical literature. Second, we used employer-reported promotions. The wage returns to both types of promotions are substantial, although an employer-reported promotion yields 30% higher returns. From the empirical analyses we concluded that employer-reported promotions are mainly associated to substantial wage increases rather than changes in the worker's job tasks or responsibilities. Wage increases upon switching employer are about 70% of the wage increase after a promotion. We interpret the substantial wage increase when switching employers as evidence that the Portuguese labor market is not competitive.

We find after controlling for both observed and unobserved heterogeneity serial correlation in wage increases and in promotions. Gibbons and Waldman (1999) argue that under full information both types of serial correlation

should be absent. We therefore conclude that employers learn about the worker's unobserved ability. Both wage increases and promotions increase the rate at which workers switch employers. We have argued that this might indicate that learning is asymmetric among employers. Only the current employer observed the workers productivity, other employers only observe the occurrences of promotions and wage increases. Therefore, these (incomplete) signals to the market may affect the rate at which workers change employers.

We have performed separate analyses for men and women and for different educational levels. The results seem to indicate that learning is more important for men than for women, we find more state dependence in wage increases for men and higher returns to promotions. This suggests that men select themselves into occupations where the unobserved ability component is more important in the worker's production function. Finally, we find that the labor market is more competitive for the lower educated workers. For this group also learning about the worker's ability is important. In Portugal educational levels are very low compared to other countries. Therefore, having a low level of education might be a very noisy signal about a worker's ability.

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Table 1: Descriptive statistics.

Description	Mean
Monthly gross wage, constant (2000) PTE	125,762
Wage increase	5329
Promotions to higher hierarchical level	7.01%
Employer-reported promotions	11.18%
Job transitions to other firm	4.40%
Female	41.16%
Worker's age (in years)	35.9
Tenure in the current firm (in years)	8.1
Number of workers in the firm	30
Level 1 Apprentices, interns, trainees	7.74%
Level 2 Non-qualified professionals	10.44%
Level 3 Semi-qualified professionals	18.27%
Level 4 Qualified professionals	47.42%
Level 5 Higher-qualified professionals	5.76%
Level 6 Supervisors, team leaders, foremen	4.36%
Level 7 Intermediary executives	2.82%
Level 8 Top executives	3.19%
Highest completed education	
No complete primary school	2.88%
Completed primary school (4 years of education)	42.02%
6 years of education completed (second ciclo)	22.89%
9 years of education completed (third ciclo)	14.10%
High school completed (12 years of education)	13.74%
University completed (15 to 17 years of education)	4.37%

Table 2: Frequency of mobility (in percentage).

Age	No change	Separation			Transition	Promotions	Observations
		Same level	Higher level	Lower level	higher level	same level	
Men							
16-25	67.01	4.29	3.23	1.96	11.91	11.59	62,763
26-35	78.05	3.45	1.41	1.16	6.17	9.76	138,046
36-45	83.48	2.25	0.57	0.59	4.39	8.73	123,484
46 -	87.22	1.31	0.23	0.31	3.24	7.68	137,269
Total	80.73	2.61	1.08	0.86	5.61	9.12	461,562
Women							
16-25	68.42	3.83	2.33	1.83	12.04	11.55	58,740
26-35	79.57	2.64	1.07	1.09	6.28	9.36	113,723
36-45	84.69	1.54	0.48	0.59	4.71	7.99	87,483
46 -	87.42	0.94	0.21	0.29	3.95	7.19	56,223
Total	80.31	2.25	0.99	0.95	6.50	9.00	316,169
All	80.56	2.45	1.05	0.90	5.97	9.07	777,731

Table 3: Mobility (in percentage) and average wage per hierarchical level.

Level	No change	Separation	Transition	Promotion	Average
			higher level	same level	wage
Level 1	51.02	8.66	34.29	17.04	74,364
Level 2	77.70	5.92	12.80	6.89	86,548
Level 3	81.76	3.81	8.35	7.54	95,532
Level 4	83.88	4.23	2.55	9.41	117,795
Level 5	81.59	2.85	4.92	10.45	194,122
Level 6	86.37	2.42	3.39	7.37	177,693
Level 7	81.22	3.25	6.77	8.45	255,188
Level 8	84.56	3.58		10.70	361,278

Table 4: Job transition matrix within and across firms.

		Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Level 1	Fraction workers (%)	65.71	3.60	9.60	19.62	0.85	0.27	0.22	0.12
	Wage increase (%)	6.32	12.54	11.52	12.92	13.87	20.51	23.95	25.98
Level 2			87.07	5.76	6.60	0.22	0.26	0.06	0.04
			2.68	6.16	9.54	13.64	16.45	15.93	29.25
Level 3				91.45	7.53	0.42	0.46	0.09	0.05
				2.79	6.10	8.25	11.13	12.38	19.61
Level 4					97.39	1.31	0.81	0.31	0.17
					3.31	8.19	10.73	13.45	16.48
Level 5						94.82	1.22	2.65	1.31
						4.42	6.77	8.57	12.31
Level 6							96.46	2.40	1.15
							3.27	7.37	10.79
Level 7								92.69	7.31
								5.30	9.65
Level 8									100.00
									5.97

Table 5: Estimation results for dynamic panel data model for wage increases ($w_{it} - w_{it-1}$).

	Δ hierarchical level		employer-reported promotion	
	(1)	(2)	(3)	(4)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	0.104*	0.116**	0.098*	0.109**
	(0.056)	(0.055)	(0.055)	(0.054)
Wage at t-2 (w_{it-2})	0.080	0.091*	0.073	0.083*
	(0.052)	(0.051)	(0.051)	(0.050)
Promotion (p_{it})	6488***	6508***	8386***	8341***
	(476)	(474)	(521)	(524)
Separation (s_{it})	4588***	4643***	5693***	5768***
	(637)	(632)	(669)	(663)
Age	377	323	368	283
	(405)	(395)	(404)	(395)
Age squared	-2.87	-2.67	-3.25	-2.38
	(2.88)	(2.84)	(2.86)	(2.83)
Tenure	-32	-20	-92	-56
	(99)	(97)	(97)	(96)
Tenure squared	-2.15	0.127	2.15	2.19
	(3.16)	(3.21)	(3.08)	(3.17)
Number of workers in firm		0.468***		0.254***
		(0.073)		(0.074)
Hierarchical level	yes	yes	yes	yes
Sector, Year	No	Yes	No	Yes
Observations	329,218	329,218	329,218	329,218

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 6: Estimation results for dynamic panel data model for promotions (p_{it}).

	Δ hierarchical level		employer-reported promotion	
	(1)	(2)	(3)	(4)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-5.16e-08	-7.88e-08	$2.84e-07$**	1.98e-07
	(1.01e-07)	(1.01e-07)	(1.44e-07)	(1.44e-07)
Wage at t-2 (w_{it-2})	-2.51e-08	-4.83e-08	$3.27e-07$**	$2.53e-07$*
	(9.60e-08)	(9.56e-08)	(1.38e-07)	(1.38e-07)
Promotion at t-1 (p_{it-1})	0.0361***	0.036***	0.0092***	0.0101***
	(0.0019)	(0.0019)	(0.0033)	(0.0034)
Separation at t-1 (s_{it-1})	−0.0123***	−0.0123***	−0.0275***	−0.0273***
	(0.0035)	(-4.83e-08)	(0.0041)	(0.0041)
Age	0.0509***	0.0521***	-0.0036	−0.0041*
	(0.0020)	(0.0020)	(0.0023)	(0.0023)
Age squared	−0.00048***	−0.00050***	-2.00e-06	4.80e-06
	(0.000022)	(0.000022)	(0.000027)	(0.000027)
Tenure	0.0162***	0.0158***	−0.0132***	−0.0131***
	(0.00081)	(0.00080)	(0.00092)	(0.00092)
Tenure squared	−0.00040***	−0.00038***	0.00041***	0.00038***
	(0.000024)	(0.000025)	(0.000041)	(0.000040)
Number of workers in firm		$7.95e-07$***		$-2.83e-06$**
		(3.69e-07)		(1.12e-06)
Hierarchical level	Yes	Yes	Yes	Yes
Sector, Year	No	Yes	No	Yes
Observations	329,218	329,218	329,218	329,218

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 7: Estimation results for dynamic panel data model for separations (s_{it}).

	Δ hierarchical level		employer-reported promotion	
	(1)	(2)	(3)	(4)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	$1.38e-06^{***}$	$1.32e-06^{***}$	$1.37e-06^{***}$	$1.31e-06^{***}$
	(1.30e-07)	(1.25e-07)	(1.29e-07)	(1.24e-07)
Wage at t-2 (w_{it-2})	$1.34e-06^{***}$	$1.28e-06^{***}$	$1.33e-06^{***}$	$1.27e-06^{***}$
	(1.22e-07)	(1.17e-07)	(1.21e-07)	(1.17e-07)
Promotion at t-1 (p_{it-1})	0.0110^{***}	0.0107^{***}	0.0103^{***}	0.0094^{***}
	(0.0018)	(0.0018)	(0.0013)	(0.0012)
Separation at t-1 (s_{it-1})	0.0832^{***}	0.0829^{***}	0.0854^{***}	0.0849^{***}
	(0.0041)	(0.0041)	(0.0041)	(0.0041)
Age	-0.1427^{***}	-0.1411^{***}	-0.1432^{***}	-0.1416^{***}
	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Age squared	0.00111^{***}	0.00109^{***}	0.00111^{***}	0.00109^{***}
	(0.000024)	(0.000024)	(0.000024)	(0.000024)
Tenure	0.1371^{***}	0.1363^{***}	0.1370^{***}	0.1362^{***}
	(0.0010)	(0.0010)	(0.0010)	(0.0010)
Tenure squared	-0.00306^{***}	-0.00302^{***}	-0.00306^{***}	-0.00302^{***}
	(0.000037)	(0.000038)	(0.000037)	(0.000038)
Number of workers in firm		$2.40e-06^{***}$		$2.31e-06^{***}$
		(3.31e-07)		(3.31e-07)
Hierarchical level	Yes	Yes	Yes	Yes
Sector, Year	No	Yes	No	Yes
Observations	329,218	329,218	329,218	329,218

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 8: Estimation results (only years after 1993) for dynamic panel data model for wage increases ($w_{it} - w_{it-1}$).

	Δ hierarchical level	employer-reported promotion
	(1)	(2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	0.135^{*}	0.123
	(0.080)	(0.078)
Wage at t-2 (w_{it-2})	0.109	0.096
	(0.074)	(0.072)
Promotion (p_{it})	6699^{***}	9278^{***}
	(642)	(759)
Separation (s_{it})	6453^{***}	7675^{***}
	(892)	(951)
Age	-129	-94
	(618)	(612)
Age squared	-1.01	-1.21
	(4.11)	(4.09)
Tenure	137	120
	(137)	(136)
Tenure squared	-7.92	-6.55
	(5.02)	(4.96)
Number of workers in firm	0.756^{***}	0.581^{***}
	(0.167)	(0.167)
Hierarchical level	Yes	Yes
Sector, Year	Yes	Yes
Observations	217,784	217,784

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 9: Estimation results (only years after 1993) for dynamic panel data model for promotions (p_{it}).

Variable	Δ hierarchical level	employer-reported promotion
	(1)	(2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	7.88e-08	$1.16e-06^{***}$
	(1.33e-07)	(2.15e-07)
Wage at t-2 (w_{it-2})	1.13e-07	$1.21e-06^{***}$
	(1.25e-07)	(2.07e-07)
Promotion at t-1 (p_{it-1})	0.0370^{***}	0.0070^{*}
	(0.0024)	(0.0041)
Separation at t-1 (s_{it-1})	-0.0107^{**}	-0.0216^{***}
	(0.0045)	(0.0048)
Age	0.0463^{***}	-0.0122^{***}
	(0.0026)	(0.0028)
Age squared	-0.00045^{***}	0.000069^{**}
	(0.000029)	(0.000029)
Tenure	0.0165^{***}	-0.0104^{***}
	(0.0010)	(0.0010)
Tenure squared	-0.00041^{***}	0.00032^{***}
	(0.000036)	(0.000036)
Number of workers in firm	-1.71e-06	-0.000017^{***}
	(1.07e-06)	(2.15e-06)
Hierarchical level	Yes	Yes
Sector, Year	Yes	Yes
Observations	217,784	217,784

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 10: Estimation results (only years after 1993) for dynamic panel data model for separations (s_{it}).

	Δ hierachical level	employer-reported promotion
	(1)	(2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	$1.31e-06^{***}$	$1.30e-06^{***}$
	(1.69e-07)	(1.69e-07)
Wage at t-2 (w_{it-2})	$1.25e-06^{***}$	$1.25e-06^{***}$
	(1.58e-07)	(1.57e-07)
Promotion at t-1 (p_{it-1})	0.0075^{***}	0.0071^{***}
	(0.0023)	(0.0016)
Separation at t-1 (s_{it-1})	0.0809^{***}	0.0826^{***}
	(0.0054)	(0.0054)
Age	-0.1389^{***}	-0.1392^{***}
	(0.0029)	(0.0029)
Age squared	0.00100^{***}	0.00100^{***}
	(0.000036)	(0.000036)
Tenure	0.1419^{***}	0.1419^{***}
	(0.0013)	(0.0013)
Tenure squared	-0.00299^{***}	-0.00299^{***}
	(0.000061)	(0.000061)
Number of workers in firm	$-5.15e-06^{***}$	$-5.16e-06^{***}$
	(1.31e-06)	(1.31e-06)
Hierarchical level	Yes	Yes
Sector, Year	Yes	Yes
Observations	217,784	217,784

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 11: Estimation results (by gender) for dynamic panel data model for wage increases ($w_{it} - w_{it-1}$).

	Δ hierarchical level		employer-reported prom.	
	Female	Male	Female	Male
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-0.014	0.167**	-0.020	0.160*
	(0.037)	(0.083)	(0.037)	(0.082)
Wage at t-2 (w_{it-2})	-0.015	0.130*	-0.022	0.123
	(0.037)	(0.076)	(0.037)	(0.075)
Promotion (p_{it})	4425***	7833***	6007***	9779***
	(395)	(763)	(367)	(866)
Separation (s_{it})	2495***	6058***	3254***	7434***
	(649)	(984)	(655)	(1046)
Age	301	441	304	332
	(290)	(700)	(291)	(703)
Age squared	0.5697	-5.13	0.6413	-4.42
	(3.17)	(4.54)	(3.17)	(4.54)
Tenure	-3	-8	-22	-56
	(111)	(145)	(111)	(143)
Tenure squared	-0.1162	-0.3867	1.29	2.11
	(3.99)	(4.50)	(4.01)	(4.41)
Number of workers in firm	0.660***	0.398***	0.497***	0.151
	(0.090)	(0.097)	(0.090)	(0.100)
Hierarchical level	Yes	Yes	Yes	Yes
Sector, Year	Yes	Yes	Yes	Yes
Observations	129,865	199,084	129,865	199,084

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 12: Estimation results (by gender) for dynamic panel data model for promotions (p_{it}).

	Δ hierarchical level		employer-reported promotion	
	Female	Male	Female	Male
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-2.18e-07	-1.88e-07	$5.75e-07^{**}$	2.47e-08
	(1.77e-07)	(1.30e-07)	(2.47e-07)	(1.82e-07)
Wage at t-2 (w_{it-2})	-1.93e-07	-1.50e-07	$7.44e-07^{***}$	3.26e-08
	(1.70e-07)	(1.23e-07)	(2.41e-07)	(1.73e-07)
Promotion at t-1 (p_{it-1})	0.0389***	0.0348***	0.0370***	−0.0081*
	(0.0028)	(0.0025)	(0.0053)	(0.0044)
Separation at t-1 (s_{it-1})	−0.0229***	-0.0050	−0.0209***	−0.0305***
	(0.0060)	(0.0044)	(0.0068)	(0.0050)
Age	0.0478***	0.0577***	−0.0099***	0.00061
	(0.0033)	(0.0027)	(0.0034)	(0.0031)
Age squared	−0.00046***	−0.00054***	0.000047	-0.000031
	(0.000039)	(0.000028)	(0.000041)	(0.000035)
Tenure	0.0163***	0.0155***	−0.0106***	−0.0146***
	(0.0013)	(0.0010)	(0.0014)	(0.0011)
Tenure squared	−0.00046***	−0.00035***	0.00032***	0.00043***
	(0.000048)	(0.000029)	(0.000059)	(0.000050)
Number of workers in firm	7.36e-08	$1.33e-06^{***}$	$-6.13e-06^{***}$	-1.15e-06
	(5.63e-07)	(4.74e-07)	(2.14e-06)	(1.31e-06)
Hierarchical level	Yes	Yes	Yes	Yes
Sector, Year	Yes	Yes	Yes	Yes
Observations	129,865	199,084	129,865	199,084

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 13: Estimation results (by gender) for dynamic panel data model for separations (s_{it}).

	Δ hierarchical level		employer-reported promotion	
	Female	Male	Female	Male
Lagged wage increase ($w_{it-1} - w_{it-2}$)	$1.28e-06^{***}$	$1.32e-06^{***}$	$1.27e-06^{***}$	$1.30e-06^{***}$
	(1.80e-07)	(1.68e-07)	(1.79e-07)	(1.67e-07)
Wage at t-2 (w_{it-2})	1.26e-06	$1.27e-06^{***}$	$1.24e-06^{***}$	$1.26e-06^{***}$
	(1.76e-07)	(1.56e-07)	(1.75e-07)	(1.56e-07)
Promotion at t-1 (p_{it-1})	0.0137^{***}	0.0084^{***}	0.0104^{***}	0.0088^{***}
	(0.0026)	(0.0024)	(0.0021)	(0.0016)
Separation at t-1 (s_{it-1})	0.0836^{***}	0.0822^{***}	0.0861^{***}	0.0839^{***}
	(0.0064)	(0.0053)	(0.0065)	(0.0053)
Age	-0.1433^{***}	-0.1394^{***}	-0.1441	-0.1397^{***}
	(0.0032)	(0.0029)	(0.0032)	(0.0029)
Age squared	0.00111^{***}	0.00107^{***}	0.00111^{***}	0.00107^{***}
	(0.000040)	(0.000031)	(0.000040)	(0.000031)
Tenure	0.1395^{***}	0.1343^{***}	0.1395^{***}	0.1343^{***}
	(0.0016)	(0.0013)	(0.0016)	(0.0013)
Tenure squared	-0.00312^{***}	-0.00295^{***}	-0.00312^{***}	-0.00295^{***}
	(0.000065)	(0.000047)	(0.000065)	(0.000047)
Number of workers in firm	$1.25e-06^{**}$	$3.08e-06^{***}$	$1.15e-06^{**}$	$3.00e-06^{***}$
	(5.61e-07)	(4.13e-07)	(5.61e-07)	(4.13e-07)
Hierarchical level	Yes	Yes	Yes	Yes
Sector, Year	Yes	Yes	Yes	Yes
Observations	129,865	199,084	129,865	199,084

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 14: Estimation results (by years of school) for dynamic panel data model for wage increases ($w_{it} - w_{it-1}$).

	Δ hierarchical level			employer-reported promotion		
	<= 4 years	6-9 years	> 9 years	<= 4 years	6-9 years	> 9 years
Lagged wage increase	0.378^{*}	0.073	0.282^{*}	0.314	0.045	0.286^{*}
($w_{it-1} - w_{it-2}$)	(0.209)	(0.121)	(0.167)	(0.192)	(0.115)	(0.167)
Wage at t-2 (w_{it-2})	0.372^{*}	0.055	0.214	0.308	0.026	0.214
	(0.210)	(0.118)	(0.144)	(0.192)	(0.112)	(0.144)
Promotion (p_{it})	5815^{***}	5819^{***}	12286^{***}	6932^{***}	7277^{***}	14645^{***}
	(1050)	(858)	(2083)	(1168)	(938)	(2077)
Separation (s_{it})	740	1796^{**}	23534^{***}	1469^{*}	2792^{**}	26317^{***}
	(778)	(797)	(4267)	(795)	(857)	(4624)
Age	-101	467	-685	38	453	-1077
	(630)	(439)	(2095)	(590)	(438)	(2160)
Age squared	-3.90	-1.94	-15.97	-3.75	-0.7392	-13.35
	(3.28)	(6.63)	(13.95)	(3.23)	(6.41)	(14.04)
Tenure	28	50	14	-25	-3	82
	(113)	(162)	(608)	(109)	(157)	(616)
Tenure squared	-1.36	-9.16	-1.83	0.8265	-6.23	-1.10
	(3.63)	(6.16)	(19.46)	(3.45)	(5.88)	(19.55)
Number of workers in firm	0.300^{***}	0.330^{***}	0.790^{***}	0.135	0.126^{*}	0.436^{**}
	(0.096)	(0.068)	(0.217)	(0.094)	(0.070)	(0.223)
Hierarchical level	Yes	Yes	Yes	Yes	Yes	Yes
Sector, Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	152,583	122,086	54,549	152,583	122,086	54,549

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 15: Estimation results (by years of school) for dynamic panel data model for promotions (p_{it}).

	Δ hierarchical level			employer-reported promotion		
	<= 4 years	6-9 years	> 9 years	<= 4 years	6-9 years	> 9 years
Lagged wage increase	$-2.35e-06^{**}$	7.46e-07	-1.08e-07	$-4.82e-06^{***}$	3.93e-07	2.95e-07
($w_{it-1} - w_{it-2}$)	(9.58e-07)	(4.82e-07)	(1.93e-07)	(1.57e-06)	(5.79e-07)	(2.70e-07)
Wage at t-2 (w_{it-2})	$-2.31e-06^{**}$	7.41e-07	-8.87e-08	$-4.90e-06^{***}$	5.00e-07	3.24e-07
	(9.65e-07)	(4.73e-07)	(1.69e-07)	(1.58e-06)	(5.69e-07)	(2.45e-07)
Promotion at t-1 (p_{it-1})	0.0262^{***}	0.0472^{***}	0.0338^{***}	0.0582^{***}	0.0095^{*}	-0.0621^{***}
	(0.0030)	(0.0029)	(0.0046)	(0.0060)	(0.0051)	(0.0070)
Separation at t-1 (s_{it-1})	-0.0098^{*}	-0.0124^{**}	-0.0137	-0.0178^{***}	-0.0219^{***}	-0.0617^{***}
	(0.0051)	(0.0060)	(0.0086)	(0.0062)	(0.0066)	(0.0100)
Age	0.0401^{***}	0.0605^{***}	0.0639^{***}	0.0134^{**}	-0.0067	-0.00070
	(0.0038)	(0.0037)	(0.0063)	(0.0054)	(0.0040)	(0.0077)
Age squared	-0.00030^{***}	-0.00066^{***}	-0.00066^{***}	-0.000033	0.000024	-0.000060
	(0.000028)	(0.000045)	(0.000076)	(0.000033)	(0.000051)	(0.00010)
Tenure	0.0129^{***}	0.0189^{***}	0.0169^{***}	-0.0112^{***}	-0.0147^{***}	-0.0183^{***}
	(0.0010)	(0.0015)	(0.0025)	(0.0013)	(0.0017)	(0.0029)
Tenure squared	-0.00029^{***}	-0.00048^{***}	-0.00038^{***}	0.00033^{***}	0.00045^{***}	0.00057^{***}
	(0.000032)	(0.000053)	(0.000083)	(0.000054)	(0.000081)	(0.00013)
Number of workers in firm	$1.94e-06^{***}$	7.64e-08	8.33e-07	$-5.06e-06^{**}$	$-4.74e-06^{***}$	2.46e-06
	(6.31e-07)	(6.17e-07)	(6.91e-07)	(2.01e-06)	(1.76e-06)	(2.01e-06)
Hierarchical level	Yes	Yes	Yes	Yes	Yes	Yes
Sector, Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	152,583	122,086	54,549	152,583	122,086	54,549

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 16: Estimation results (by years of school) for dynamic panel data model for separations (s_{it}).

	Δ hierarchical level			employer-reported promotion		
	<= 4 years	6-9 years	> 9 years	<= 4 years	6-9 years	> 9 years
Lagged wage increase	0.000015^{***}	$7.74e-06^{***}$	3.24e-07	0.0929^{***}	$7.69e-06^{***}$	3.26e-07
($w_{it-1} - w_{it-2}$)	(2.52e-06)	(1.15e-06)	(2.12e-07)	(0.0079)	(1.14e-06)	(2.12e-07)
Wage at t-2 (w_{it-2})	0.000015^{***}	$7.65e-06^{***}$	2.90e-07	0.000015^{***}	$7.60e-06^{***}$	2.92e-07
	(2.54e-06)	(1.13e-06)	(1.90e-07)	(2.47e-06)	(1.12e-06)	(1.90e-07)
Promotion at t-1 (p_{it-1})	0.0277^{***}	0.0120^{***}	0.0079^{*}	0.0271^{***}	0.0126^{***}	0.0036
	(0.0042)	(0.0033)	(0.0041)	(0.0038)	(0.0027)	(0.0023)
Separation at t-1 (s_{it-1})	0.0888^{***}	0.0899^{***}	0.0784^{***}	0.0929^{***}	0.0925^{***}	0.0800^{***}
	(0.0079)	(0.0069)	(0.0090)	(0.0079)	(0.0070)	(0.0090)
Age	-0.1381^{***}	-0.1743^{***}	-0.2206^{***}	-0.1378^{***}	-0.1746^{***}	-0.2216^{***}
	(0.0076)	(0.0047)	(0.0073)	(0.0075)	(0.0048)	(0.0073)
Age squared	0.00064^{***}	0.00109^{***}	0.00198^{***}	0.00065^{***}	0.00110^{***}	0.00199^{***}
	(0.000037)	(0.000065)	(0.00010)	(0.000037)	(0.000065)	(0.00010)
Tenure	0.1213^{***}	0.15536^{***}	0.1706^{***}	0.1210^{***}	0.1552^{***}	0.1707^{***}
	(0.0019)	(0.0023)	(0.0033)	(0.0018)	(0.0023)	(0.0033)
Tenure squared	-0.00255^{***}	-0.00372^{***}	-0.00413^{***}	-0.00253^{***}	-0.00372^{***}	-0.00413^{***}
	(0.000063)	(0.000090)	(0.00014)	(0.000062)	(0.000089)	(0.00014)
Number of workers in firm	$3.70e-06^{***}$	3.19e-07	9.08e-07	$3.54e-06^{***}$	1.87e-07	8.73e-07
	(1.06e-06)	(6.33e-07)	(5.95e-07)	(1.06e-06)	(6.37e-07)	(5.95e-07)
Hierarchical level	Yes	Yes	Yes	Yes	Yes	Yes
Sector, Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	152,583	122,086	54,549	152,583	122,086	54,549

Clustered standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Appendix: Structure of the skill levels - Decreto-lei n. 121/78, 2nd June.

Level	Tasks	Skills
1 - Apprentices, interns, trainees	Training for a specific task.	Identical, but without practice, to the professional of the qualification level they will be assigned.
2 - Non-skilled professionals	Simple tasks, diverse and usually not specified, totally determined.	Practical knowledge and easily acquired in a short time.
3 - Semi-skilled professionals	Well defined tasks, mainly manual or mechanical (no intellectual work) with low complexity, usually routine and sometimes repetitive.	Professional qualification in a limited field or practical and elementary professional knowledge.
4 - Skilled professionals	Complex or delicate tasks and usually not repetitive and defined by the superiors.	Complete professional qualification implying theoretical and applied knowledge.
5 - Higher-skilled professionals	Tasks requiring a high technical value and defined in general terms by the superiors.	Complete professional qualification with a specialization adding to theoretical and applied knowledge.
6 - Supervisors, team leaders, foremen	Orientation of teams, as directed by the superiors, but requiring the knowledge of action process.	Complete professional qualification with a specialization.
7 - Intermediate executives	Organization and adaptation of the guidelines established by the superiors and directly linked with the executive work.	Technical and professional qualifications directed to executive, research, and management work.
8 - Top executives	Definition of the firm general policy or consulting on the organization of the firm. Strategic planning. Creation or adaptation of technical, scientific and administrative methods or processes.	Knowledge of management and coordination of firm's fundamental activities. Knowledge of management and coordination of the fundamental activities in the field to which the individual is assigned and that requires the study and research of high responsibility and technical level problems.